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XII.—*On the Formation of Cyclones and the Tracks they pursue.*

By Captain ALFRED PARISH.

Communicated by Captain R. FITZROY, R.N., F.R.G.S.

Read, February 28, 1856.

WITH much diffidence I advance a theory which appears to me to supply some explanation of the formation of cyclones and of the tracks they pursue: the result of a long, practical, and close study of the winds and weather which I have met with in my own voyages, and from the investigation of a number of log-books to which I have had access.

All winds, except where influenced by the proximity of much land, appear to me to be parts of cyclones obeying in their respective hemispheres the laws which have now been proved to govern hurricanes, both with regard to their tracks and rotatory motions.

By the term cyclones, I mean rotatory winds advancing on a line. When of very large diameter, such as those of which trade winds may form a part, they strike the surface diagonally; but where of limited diameter, as in the higher latitudes, or of still less diameter, as in the hurricanes of the tropics, they descend horizontally, or so nearly that from their small size they may be looked upon practically as being so. They invariably increase in strength towards the centre, and the less their diameter the greater the force of wind seems to be.

About the tropics, easterly winds are to be found, veering towards the equator, more directly as they near it; but gradually veering more from the westward, and in many places becoming due westerly on the equator, or, more correctly speaking, *about* the equator, for the belt of westerly winds appears to move more northerly or southerly, as the sun is in north or south declination. These winds seldom exceed a fresh gale, when the sun has been long in the opposite hemisphere. But in that hemisphere in which the sun has long been, cyclones arise of limited diameter and of hurricane force, also having westerly winds on the equatorial, and easterly winds on tropical quadrants; blowing directly towards the equator on their westerly quadrant, and moving invariably towards the west. Their tracks slightly incline towards the south in southern, and north in northern hemispheres, and disappear about the tropics.

Immediately without the tropics, cyclones appear to me to form of greater diameter than those within, and to travel towards S.E., E.S.E., and finally due E. as they approach lat. 28° or 30°.

In higher latitudes, quoting from my own observations only, I look upon the winds as blowing in a constant succession of cy-

clones, of probably 1000 m., or thereabouts, in diameter, descending upon the surface horizontally and moving on parallel lines, travelling invariably towards the E., but never equalling in force the hurricanes of the tropics. I would point out the great regularity which prevails in high latitudes in the southern hemisphere, in the succession of these cyclones. First we find light air springing up from the northward, being, I conceive, the easterly part of a cyclone overtaking the ship: then a steady wind from the northward for several days, if the cyclone is moving at a moderate rate, water smooth and ship sailing well; then a north-west and west-north-west wind for some days increasing in strength; then a sudden shift of wind to S.W. squalls, moderating, wind hauling to the southward, and either falling calm as the cyclone leaves the ship, or blowing fresh from the S.E. for a day or two. The changes of wind and fall of barometer until just before the shift to south-west, when it begins to rise again, will point out the cyclone's rate of progression and exact track. The navigator is thus enabled to foretell with certainty how the wind will be, and of what force for some days, and may even choose the strength of wind most advantageous for him in many instances, by hauling more or less to the northward.

I have found these laws to apply equally to the gales of wind between the Azores and the British Channel, but their diameter appears to me to be much larger there, and consequently the changes cannot be taken so much advantage of.

I may here also mention that I have several times found a cyclone of about 700 m. in diameter, to the southward and on the meridian of Cape L'Agulhas, nearly stationary when on the S.W. quadrant of it, with the wind from S.E. A ship bound to the eastward, by standing to the south-south-west, will find the wind haul gradually to east and east-north-east, and thus sail round it and proceed with a northerly wind.

In endeavouring to trace the cause of these winds, let me first consider those within the tropics.

The heat of the surface not being so great in one hemisphere when the sun has been long in the opposite one, the air from the extra tropical regions would flow in evenly and continuously, and thus occupy the space between the tropics and the equator in one mass; we should look then for steady winds except where influenced by large continents or other local causes. When it first reached the surface within the tropics, the difference between its rotatory velocity and that of those regions would be great; it would move towards the E. more slowly than the earth's surface there, and consequently would make a current of wind from the eastward; but being at the same time urged on towards the more heated regions nearer to the equator, the wind would become south-east in southern, and north-east in northern latitudes. After

passing over a few degrees of latitude it would participate more nearly in the motion of those parts; the difference of velocity would diminish, and the impulse towards the equator become more direct, forming a southerly wind in southern and a northerly in northern hemispheres. As it neared the equator, it would acquire still more nearly the velocity of the surface, and become first a south-westerly or north-westerly and then a westerly wind, not from gaining upon the earth in its motion, but by lagging less behind than the rest of the mass, the whole of such mass moving apparently towards the westward. Having become heated, it would then rise and flow over towards the poles, thus forming a circle striking the surface diagonally. In some parts of the equatorial regions the southern cyclone seems to rise from the surface at that point which represents the s.w. or s.s.w. winds, and the northern one at that representing the n.w. or n.n.w. winds; while in other parts, especially towards large continents, the due westerly winds appear to extend over many degrees of longitude. May this not be from local influences or difference in the humidity of the atmosphere causing a variation in the angle at which the cyclone strikes the surface diagonally?

When the surface within the tropics is overheated by the sun's long presence over one hemisphere, the air expanding and rising more rapidly from that hemisphere, and consequently the colder air rushing in with greater force; is it unreasonable to suppose that, instead of forming one large cyclone, it should be broken up at times into smaller ones, which, from being transferred so much quicker than usual from one region to another, would reach the surface with far greater difference of velocity and impulse, and thus form cyclones of hurricane force and small diameter? Each cyclone, bringing its polar velocity with it, would then lag behind the earth, or more apparently to the westward, and being under the same influences as the larger circle of steady winds would veer the same way, namely, easterly winds on the segment towards the tropics, blowing towards the equator on its western side, and from the westward on its equatorial side. Would not each of these small masses, detached with great violence from the larger cyclone, naturally complete the eddy with incurving circles such as we find in tropical hurricanes?

With respect to the cyclones of the higher latitudes, two theories offer themselves to my mind.

1st. The heated equatorial air, while it rises and flows over towards the poles, carries with it the rotatory velocity due to its equatorial situation, into higher latitudes, where the earth's surface has less motion. Hence, when it first returned to the surface, in its circulation beyond the tropics, it would gain on the earth in the motion of rotation there, and therefore move bodily to the eastward, forming apparently a westerly wind. Advancing over a

few degrees of latitude, it would, by participating more nearly in the velocity of those regions, blow more directly towards the poles; and afterwards, though still gaining upon the surface, it would, by dragging as it were more upon the earth, and thus lagging behind the rest of the mass, cause an easterly wind on that quadrant of it nearest to the poles. Ultimately, the air would be drawn away towards the more heated equatorial regions, and thus complete the revolution of the cyclone.

2nd. In offering my second proposition, I select the southern hemisphere to save confusion of terms.

The air flowing over towards the poles with a greater rotatory velocity, would, when its influence in descending was first felt at the surface, be a light breeze from north-north-west, or thereabouts; as it continued to descend, it would increase in strength, gradually lose its impulse towards the pole, and therefore become a strong westerly wind; when it reached its lowest point, the gale would then be at the heaviest, it would then begin to flow in towards the equatorial regions, and thus form a south-westerly wind. The space would then be re-occupied, either by another descending current, or by winds from still higher latitudes flowing in towards more heated regions. In the first case, it would finish with light airs from the southward, to recommence at N. and N.W.; in the second case, after the south-west winds, it would blow from S.E. and E.

To any ship or person stationary upon the surface, I apprehend either the 1st or 2nd proposition would represent the apparent succession of cyclones, such as I have noticed above as prevailing in high latitudes.

With respect to the cyclones between 25° and 30° latitude, which are generally considered, I believe, to be those of the tropics recurring, I am induced to think that they only commence there; having several times in those latitudes on both sides of the Cape of Good Hope, though more frequently about the meridian of the Mauritius, found small whirlwinds arise, the wind blowing in sudden sharp puffs and always veering the way the regular hurricanes do in that hemisphere. The ship having gone round and round several times, and the puffs increasing in steadiness and duration, I have tried the experiment with success, of striking off from the centre, when on that part of the circle which should give me the wind I required.

May these cyclones not be formed by the descending winds from the tropical regions, which, meeting the surface with a greater rotatory velocity, thus acquire their south-easterly and easterly course? The theory I have advanced for the veering of cyclones in higher latitudes, would apply also to those in this zone.
